Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/262
UNITED STATES
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

DEVELOPMENTS IN RESONANCE ABSORPTION

Jack Chernick (Brookhaven National Laboratory)
Melvin M. Levine (Brookhaven National Laboratory)

Analytical methods for calculating the resonance absorption of neutrons in reactors have been greatly improved since 1958. Improvements include Rothenstein's extensive work on second-order corrections (1959), the Goldstein and Cohen intermediate resonance formulas (1962), and Nordheim's numerical code for the direct solution of an energy-dependent integral equation (1961).

The close analogy between the integral equations for homogeneous and heterogeneous systems has led to a series of equivalence theorems of generally increasing sharpness. These include Bakshi (1957), Dresner (1958), Bell (1958), Rothenstein (1959), etc. In tightly packed lattices the Dancoff correction is important. Improvements in its determination for rod lattices were made by Thie (1958), Takahashi (1960), Fukai (1960) and Sauer (1962). Levine (1963) has found improved equivalence relations for a variety of uranium-bearing rods in water and of uranium-metal rods in D_2O and graphite.

As cognizance of the accuracy of the theoretical methods has spread, more accurate integral experiments have been devised to test aspects of the theory. In particular, the work of Hellstrand and his collaborators, of Hardy, Klein and Smith of Bettis and of Kouts' group at Brookhaven have resulted in sharp improvements in the precision of these integral experiments. Examples are resonance integrals measured by Hellstrand, et al (1960, 1961) and by Rothman and Ward (1961), and the Bettis measurements of Dancoff factors in water lattices (1962) and of the spatial distribution of resonance capture in a uranium rod (1961). Considerable improvement has also been obtained in experimental measurements of Doppler coefficients. The importance of Doppler

coefficients to the safety of large fast reactors has spurred considerable interest in their measurement and in obtaining improved neutron resonance data in the statistical region.

The present generation of very high speed digital computers has broadened the use of Monte Carlo calculations. Many of the limitations of the original REP code have been eased, including limitations on the number of resonance absorbers and on geometrical routines. A remaining difficulty is that a proper representation of multilevel interference effects in closely spaced resonances of fissionable materials is still not available. Some progress is expected from the present concerted effort on measurements of low-energy resonance structure and from better methods of curve fitting such as that proposed by F. Adler. The Monte Carlo code MOCCA perfected by H. Rief has made it possible to investigate high-energy resonance capture with good accuracy. Studies by Levine (1963) have clarified the differences between resonance capture in a 1/E spectrum and those of an actual reactor lattice.

Resonance absorption in water lattices has been thoroughly studied by Drawbaugh (1960), Rothenstein (1960) and Levine (1963). The results of these calculations have helped improve the accuracy with which the nuclear properties of these lattices can be predicted, as shown by Hellens and Honeck (1962). Similar studies are proceeding for other moderators. The adequacy of simple methods of dealing with rod clusters is still largely untested.